SOME OBSERVATIONS ON THE OCCURRENCE OF ACIDOSIS AFTER ANÆSTHESIA

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THE condition termed "acidosis", exclusive of the acidosis of diabetes, is one of fairly frequent occurrence in surgical practice, if one includes all cases in which there is an actual lessened alkaline reserve in the blood of the patient.

Restricting the use of the term to those cases which show actual clinical symptoms, this condition is fortunately much more rare; but these cases do occur often enough to make the condition one of concern to every practitioner.

We may recall briefly the clinical picture presented by these cases, which vary in severity from those showing rather prolonged nausea and vomiting, headache and slight restlessness, to those cases where the patent rouses from the anæsthetic only to lapse into a rapidly deepening coma, with rising temperature, pulse and respiration rates, and with death supervening within twenty-four or forty-eight hours.

Between these extremes, of course, lie the majority of those cases in which attention is attracted especially to this condition. In these cases the patients usually vomit excessively, and instead of diminishing the nausea and vomiting increase, the temperature and the pulse rate rise, the pulse often alarmingly; and a characteristic type of breathing appears. In this the nostrils are widely dilated, the mouth usually open, too, and the patient seems to be gasping for breath. It seems as though in spite of the fact that there is no obstruction the patient is not inhaling enough air for his needs, and, in effect, this is just what is happening. There is plenty of air getting into the lungs, but the blood has lost to a greater or less extent, its power of carrying oxygen, and the patient actually is "air-hungry".

Some four years ago, following what might almost be termed an epidemic of cases occurring for the most part among our out-patients tonsil cases, we began a routine examination of the urine

of all cases coming to operation and subsequently began to make an additional post-operative urinalysis, from all cases under one of the surgical services. This routine examination of anti-operative urine included tests for albumin, sugar, acetone and diacetic acid. We made no examinations of the blood of any of these patients, though we became convinced as our experiments proceeded, that an urinalysis would only be of value in those cases where elimination parallels formation of acid bodies; and we had no means of knowing whether this was the case in any of our patients. We came to this conclusion when we found that many patients excreted large amounts of acetone and diacetic acid in the urine, and had no symptoms, while we occasionally found patients in whom the toxæmia was fairly marked and who excreted little or no acetone or diacetic acid. And we came to believe that the patients who showed no symtoms except the presence of acid-bodies in the urine, did so because they were excreting practically all the acid bodies formed, and so did not encroach on their alkaline reserve, while in those cases where marked symptoms appeared, with no corresponding urinary findings, the patients were forming acid bodies in large amounts, and not excreting any.

We did not observe that the particular anæsthetic used made any difference in those cases giving positive results in the urinary tests, although we had no cases of pure chloroform anæsthesia in our series. It appeared that the nitrous oxide patients more seldom developed symptoms than others, but their urinalysis results were not appreciably different. We have no record of a case operated under local anæsthesia developing marked symptoms, though several vomited, and many gave positive urinary findings following operation.

We did not find that length of operation was a factor in the development of symptoms; on the contrary most of our severe cases were among children operated for removal of tonsils and adenoids, in whom the trauma of operation was comparatively slight, the amount of anæsthetic used small, and the length of anæsthesia, including the induction period, only about ten minutes.

We found about 22 per cent. of our patients with acetone and 15 per cent. with diacetic acid in the urine before operation. Caldwell and Cleveland of New York, in a very interesting article in the July, 1917, number of *Surgery, Gynæcology and Obstetrics* state that 23 per cent. of their patients had acetone, while 13 per cent. had diacetic acid, these figures corresponding fairly closely with ours. But while they give figures of 72 per cent. and 56 per cent.

respectively for the acetone and diacetic acid tests in their post-operative examinations, our figures never showed more than 50 per cent. with aceton and about 35 per cent. with diacetic acid, and this only in the earlier period of our experiments. Later, following the adoption of more liberal feeding before operation, no purgation except an enema the morning of operation, and earlier and more plentiful feeding following operation, these figures were still further reduced.

Of these patients showing acetone and diacetic acid before operation, the large majority were patients who had been ill for some time, some with infections, many of them with the toxæmia of pregnancy, with pathological conditions causing varying degrees of starvation, or were children who had not been actually ill, but in whom one could trace the effects of too little food, or of some type of malnutrition. Some of the children were apparently healthy, but in these one could not overlook the element of starvation for the twelve or eighteen hours preceding operation.

On the other hand, practically all the emergency cases where the condition calling for operation involved the intestinal tract, with the exception of injuries, showed varying degrees of acidosis clinically, and almost invariable presence of acid bodies in the urine, and both the amount found and the severity of the symptoms appeared in these cases to increase with the length of time the patient had been ill before coming to operation. That is to say, those patients who came to operation within twelve hours of the onset of an attack of appendictis usually showed no symptoms, and gave slight reactions in their urinalysis, while those patients who came in from two to three days or later, with abscess formation or peritonitis, usually displayed marked symptoms and gave more marked reactions. Whether this almost constant factor of acidosis in acute abdomens results from the presence of infection, as in appendicitis, or whether it results from the voluntary starvation of the patient and the vomiting of his illness, we were not able to determine; but we came to the conclusion that not only did the presence of these bodies in the urine not contraindicate operation, in acute conditions, but was an additional indication for it, since these cases usually rapidly improved following operation, in so far as urinary tests for acid bodies, and the clinical symptoms of acidosis, when present, were concerned.

It appeared that women more frequently developed acidosis than men, though this predominance was not marked. But it is certainly true that children were far more susceptible to this con-

dition than adults. So far as adults were concerned, the question of age did not seem to figure, since aged people did not develop it more frequently than those in the prime of life, unless one considers also among them the greater frequency of malignant conditions giving rise to starvation.

Children especially, but also adults, who exhibited great fear, appeared to develop symptoms of acidosis more often following operation, and this even when there had been no trace of acetone or diacetic acid in the urine beforehand. But it was not determined whether this fear was a factor in the subsequent development of acidosis, or whether the fear was simply one of the nervous manifestations of a pre-existing acidosis which was not shown in the excretions of the kidneys.

The mental factor in this condition is a very real one, and we have come to the conclusion that more attention given to the night's rest which the patient gets before operation and more attention paid to the type of induction of anæsthesia would repay us. Bromides are perhaps preferable to morphine, the night before operation, and it may be that it would be wise to make this routine treatment for all adults. A dose of morphine suitable to the individual patient, and combined with atropine, should be given from a half to one hour before operation. This and an induction slow and careful enough to eliminate the patient's sense of smothering and danger, and to prevent any actual deprivation of oxygen, and a tactful attempt to "humour him along" till consciousness has left him, certainly seem to us to be factors in the prevention of acidosis, and especially so in those very cases where one has most reason to fear its occurrence.

It has been our experience that the average patient showing acetone and diacetic acid in the urine before operation, but with no clinical symptoms can be safely operated, though they are to be closely watched and should be treated with soda and glucose in some form, as a routine. We have also found that when the acidosis depends upon the condition requiring operation, as a gastric ulcer, it is fairly safe to operate on such patients if there are no clinical symptoms; and if there are, to institute treatment, wait for a few days, and then operate, recommencing the treatment immediately. In the case of children coming for operations for which there is no special urgency, such as tonsillectomies, we have followed the practice of deferring operation, and feeding the child with sugars and carbohydrates in any form which he will take, also laying stress on large amounts of water, until the reactions are

negative and the child shows no clinical symptoms. One should repeat that this negative result of an urinalysis is only an approximate indication of the state of the patient's blood and when there is any doubt the blood should be examined.

We came to the conclusion that practically all these cases are simply a matter of feeding so far as treatment is concerned. For the prevention of symptoms of acidosis we believe that all cases coming to operation should be well-fed up till the morning of operation; that if operation is to be late in the morning they should have a light breakfast and should have water until within two hours of operation. This of course is not intended to apply to gastric surgery. Purgation is not advised; it has been found that an enema the morning of operation is usually sufficient. Bromides the night before, and a dose of morphine before operation are advisable, the latter because it does lessen the amount of anæsthetic required, to some extent, and because it makes the induction easier for the patient as a rule.

In adults we do not believe that there is necessity for active treatment with sodium bicarbonate as a routine, though any case which gives positive reactions in the urine, for acid bodies, or gives clinical symptoms, should at once be put on treatment.

Following operation the patient is to be encouraged to drink quantities of water as soon as conscious and to eat good as soon as possible. He will probably vomit what he drinks and what he eats, at first, but he will recover from his post-anæsthetic nausea all the sooner for that. The diet should be increased to normal as rapidly as possible. If acetone appears in the urine and especially so if clinical symptoms appear, sodium bicarbonate in large doses, and glucose should be given, and if the condition is at all alarming these may be given intravenously. Three of our cases where the vomiting was most distressing and persistent ceased vomiting almost magically following intravenous injections of a solution of soda. In all these cases the urine showed both acetone and diacetic acid, which rapidly disappeared following the injection. No blood tests were made in any of these three.

In children on the other hand, we feel that it may be the part of wisdom to give all of them preventive treatment. That is to say, all children coming to operation should be over-fed for some days at home before coming to the hospital, they should have a full meal the night before operation, and should have rich gruel with sugar early in the morning of the operation; or if the operation is not to occur till late in the forenoon should have breakfast. They

should not be given milk on the day of operation, since it is apt to form curds and give trouble when the child vomits. Broth, gruel, plenty of water, and besides this, as a routine measure, a capsule, containing five grains each of sodium bicarbonate and glucose, before operation. This may be followed after operation by further active treatment, along the same lines if it appears necessary, but it is believed that if this procedure were carried out before operation, post-operative treatment for acidosis would only rarely be necessary in children.

We wish to acknowledge the assistance and encouragement of the staff surgeons of the hospital in what work we have done along these lines.

THE Medical Faculty of McGill University have recently passed the following resolution:

"That the Faculty of Medicine of McGill University has received with the greatest appreciation information from Mr. J. D. Rockefeller of his donation of five million dollars for the cause of medical education in Canada. . . . Be it resolved, at the first opportunity, therefore, that this faculty, records its gratitude to Mr. John D. Rockefeller for his great benefaction, and further the assurance that, in so far as lies in their power, every effort will be made to co-operate with other institutions to attain such results as would satisfy the expectations of the Foundation."